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OF THE

AMERICAN PHYSICAL SOCIETY

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PROGRAM OF THE

SALT LAKE CITY, UTAH MEETING

UNIVERSITY OF UTAH

JUNE 15, 1933

IN AFFILIATION WITH

THE PACIFIC DIVISION OF THE
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

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AMERICAN PHYSICAL SOCIETY

SALT LAKE CITY MEETING, JUNE 15, 1933

IN AFFILIATION WITH

THE PACIFIC DIVISION OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE 185th regular meeting of the American Physical Society will be held at the University of Utah, Salt Lake City, Utah, in Room 313, Physical Science Building, in affiliation with the Astronomical Society of the Pacific and the Pacific Division of the American Association for the Advancement of Science, Thursday, June 15th, 1933.

Titles and abstracts of the papers to be presented are given in the following pages. These abstracts have not been corrected by the authors. After correction, they will be published in an early number of the Physical Review. Authors should send corrections to the Editorial Secretary, American Institute of Physics, 11 East 38th Street, New York, New York.

There will be two sessions of the Society, the first one being on Thursday morning, June 15th, at 9 A.M. in Room 313, Physical Science Building, and the second being a joint session with the Astronomical Society of the Pacific at 2 P.M. on Thursday, June 15th, in Room 313, Physical Science Building.

Dinner. On Thursday evening, June 15th, there will be an informal dinner for members of the Physical Society and the members of the Astronomical Society of the Pacific who care to attend, to be held if possible, at the Union Building at 6:30 P.M.

Luncheon. On Thursday the members of the Physical Society will meet at an informal luncheon in the Union Building at 12:30.

All members of the Physical Society are requested to register on arrival at the registration desk in the general headquarters in the Union Building.

Hotel Accommodations. Hotel Utah, single room without bath, $1.50 to $2.50; single room with bath, $2.50; double room with bath, $5.00 up. Hotel Newhouse, single room with shower, $2.00 to $3.00; double rooms with shower, $3.00 to $4.00. Rooms may be had at the Emory Memorial House, a dormitory for men, located just off the campus and near the Union Building. Rooms at reasonable rates will also be available at several of the fraternity and sorority houses located near the campus. These can be arranged for at the general headquarters in the Union Building. Several recommended auto camps are as follows: the Casa Blanca Auto Camp, at 1489 South State, with apartments having shower bath, kitchen, etc., rates $2.50 for two persons, $3.50 for four persons. The Capitol Tourist Apartments, at 1767 South State, rates the same as the Casa Blanca. The Utah Motor Park, located at 1000 South State. Meals: breakfast, luncheon and dinner will be served in the Uni-

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versity cafeteria, located in the Union Building, the general headquarters for the meeting.

Other meetings for the current season are as follows:

186. June 19–24, 1933, Chicago, joint meeting with A.A.A.S.

187. December 1–2, 1933, Cincinnati.

188. December, 1933, Stanford University, California, time to be announced later.

189. December, 1933, Boston. Annual Meeting.

LEONARD B. LOEB
Secretary for the Pacific Coast
University of California, Berkeley, Calif.

June 1, 1933.

PROGRAM

THURSDAY MORNING, JUNE 15TH, AT 9 O'CLOCK

Room 313, Physical Science Building

1. High Terms in the Spectra N^{V} and O^{V}. WILLOUGHBY M. CADY, *California Institute of Technology.*—Certain plates exposed a year ago in the vacuum spectrograph previously described (Phys. Rev. **43**, 322, 1933) have now been analysed. The source was a condensed discharge through air at a pressure of about 0.5 mm Hg, taking place in a quartz tube 9 cm long and of 2 mm bore. About fifty discharges of the 0.33μF condenser at about 25,000 volts sufficed for a good exposure between 105 and 350A, showing known lines of N^{IV}, N^{V}, O^{IV}, O^{V}, and O^{VI}. New lines have been identified, which fix thirteen new levels in N^{V}, and thirty-six in O^{V}. Thus most of the bright lines on the plates have been identified; e.g. of the hundred lines with an estimated intensity of 3 or more, only about one quarter remain unassigned.

2. Hyperfine Structure and Nuclear Moment of Columbium. NORMAN S. GRACE (Commonwealth Fellow) and STANLEY S. BALLARD, *University of California at Berkeley.* (*Introduced by Leonard B. Loeb.*)—King (Astrophys. J. **73**, 13, 1931) observed a wide hyperfine structure in the arc spectrum of columbium. He found that many lines were broad enough to contain six components and some possibly eight. A very rich columbium I spectrum was excited in a Schüler tube cooled in liquid air and photographed with a glass spectrograph crossed with Fabry-Perot etalons. Although it has not yet been possible to completely resolve the lines possessing most complex structure we have found λλ4059, 4675 and 5344 to possess at least eight components and λ4672 eight and probably more components. From intensities and intervals it is concluded that $I \geqslant 7/2$ for columbium.

3. Hyperfine Structure of Molybdenum. NORMAN S. GRACE (Commonwealth Fellow) and KENNETH R. MORE, *University of California at Berkeley.*—Mo I lines were excited in a liquid air cooled Schüler tube and photographed with a glass spectrograph and silvered Fabry-Perot etalons. λλ5507, 5533, 5571 ($4d^5\,5s\,{}^5S_2 - 4d^5\,5p\,{}^5P_{123}$) and λλ5792, 5858, 5888 ($4d^4\,5s^2\,{}^5D_{2,\,3} - 4d^5\,5p\,{}^5P_{1,\,2,\,3}$) with invar etalon separators, up to 20 mm showed no structure. With separators which were varied from 32 to 58 mm faint structure was observed in all of these lines. Aston reports for the isotopes of molybdenum, mass 92, 14.2 percent, 94, 10.2 percent, 95, 15.5 percent, 96, 17.8 percent, 97, 9.6 percent, 98, 23.0 percent, and 100, 9.8 percent. Thus one might expect hyperfine structure due to the isotopes of odd atomic weight by virtue of their mechanical and magnetic moments and also structure due to an isotope shift. The separations and intensities of the structure observed indicate that for at least one of the odd isotopes $I \geqslant \frac{1}{2}$, that the nuclear g-factors for both odd isotopes are small and that the isotope shift is extremely small. The very small magnitude of isotope shift observed in molybdenum in contrast with that observed in the spectroscopic homologue tungsten is of interest in connection with the theory of isotope shifts.

4. Hyperfine Structure and Nuclear Spin of Lanthanum. H. E. WHITE and O. E. ANDERSON, *University of California at Berkeley.*—The arc spectrum of lanthanum was excited in a Schüler tube cooled in liquid air. Fabry and Perot etalons were used to investigate the hyperfine structure of line 6249.9A, which is the transition ${}^4G_{11/2} - {}^4F_{9/2}$. A 9 mm separator showed that this line had eight components. One of the authors, H. E. White (Phys. Rev. **34**, 1404 (1929)), from the work of Meggers and Burns suggested that the nuclear spin of lanthanum was at least 5/2. This present work indicates that the spin is 7/2.

5. Remarks on the "Lines" of Diffraction Gratings. HAROLD D. BABCOCK, *Mount Wilson Observatory.*—In most text books the elementary theory of the diffraction grating is given only for the case in which transparent or highly reflecting strips of an optical surface are separated by opaque, non-reflecting spaces of approximately the same width. Modern gratings ruled on metallic surfaces are distinctly different from this case in that the original

polished surface of the metal is entirely destroyed and the burnished walls of the grooves formed by the ruling tool reflect the light largely in certain chosen directions. By means of photomicrographs and diagrams these types of gratings are illustrated. For a metal grating the effect is shown of varying the relation between the spacing of the grooves and their depth. The design of the shape of the groove to produce a desired concentration of diffracted light is described. Typical ruling diamonds are exhibited. Attention is called to Michelson's theory of the modern type of grating.

6. Measurement of the Townsend Coefficients for Ionization by Collision. FREDERICK H. SANDERS, *University of California at Berkeley.* (*Introduced by Leonard B. Loeb.*)—The photoelectric current between parallel plates in dry air was measured as a function of plate distance for constant field strength and pressure over plate distances ranging from 1 to 7 cm and at a pressure of 1 mm of mercury. The simple Townsend relation $i=i_0e^{\alpha d}$ was found to give excellent agreement for values of X/p from 40 to 110. The values of α/p plotted as a function of X/p lie on a smooth curve which does not fit either the equation $\alpha/p=Ce^{-CV_0p/X}$ suggested by Townsend nor the empirical relation $\alpha/p=Ae^{b(X/p)}$ found by the writer to hold for values of X/p from 20 to 36.5. Voltages and plate distances were measured to within 1/10 of 1 percent and pressures to 1/2 of 1 percent or better. For X/p's from 120 to 160 the current was found to increase with plate distance more rapidly than the simple exponential relation would indicate, as was observed by Townsend for plate distances less than 1 cm at much greater X/p's. The early appearance of this deviation may be ascribed to the greater sensitivity given by larger plate distances. Both of the relations suggested by Townsend:

$$i=i_0\frac{(\alpha-\beta)e^{(\alpha-\beta)d}}{\alpha-\beta e^{(\alpha-\beta)d}} \qquad (1)$$

which was derived on the assumption that each positive ion produces β new pairs of ions by collision in 1 cm of path, and

$$i=i_0\frac{e^{\alpha d}}{1-\gamma(e^{\alpha d}-1)} \qquad (2)$$

which assumes γ new electrons liberated by each positive ion which strikes the cathode, fit the experimental curves equally well. The values of β/p were found to increase steadily with X/p as found by Townsend for higher X/p's. The coefficient γ, which is approximately equal to β/α, was found to increase only very slightly over this small range of X/p's.

7. Uranium and Thorium Content of Rocks Determined from their Surface Radiation. ROBLEY D. EVANS, *National Research Fellow. University of California at Berkeley.*—Following the initial work of Graven (Akad. Wiss. Wien, 2A, **139**, 181 (1930), *ibid.* **141**, 515 (1932)), an attempt was made to measure the sum of the uranium and thorium content of rocks by means of alpha and beta-rays emitted from the surface of the rocks. These were detected with a Workman-DeVore quartz fiber electroscope having two 75 cm² windows of 0.8μ aluminum, hence a stopping power of only *ca.* 1.3 mm of air. That *ca.* 90 percent of the ionization is due to alpha-rays, *ca.* 10 percent to beta-rays, and none to gamma-rays was demonstrated by using aluminum and lead screens with the ionization chamber, as well as by oscilloscope observations employing a sensitive linear amplifier. The technique becomes quantitative by employing smooth semi-polished surfaces of rocks, in which a definite amount of surface is exposed. Absorption measurements in both pure and poisoned gypsum were made using artificial rocks composed of gypsum poisoned with minute quantities of thorium and uranium and their decay products. These measurements confirm the experiments of Graven for the uranium series but definitely disagree with his thorium measurements. The existence of intense secondaries from gypsum under the action of feeble γ-radiation, and the dependence of the method on γ-radiation, as reported by Graven, were not confirmed. Although a slightly different absorption ratio for the Th and U series in gypsum was observed, the difference was *not sufficiently large* to provide a practical basis for evaluating both the thorium and uranium content of ordinary rocks. The unscreened radiation from rock surfaces is, however, capable of indicating the sum of the uranium and thorium content of a specimen, and if either can be measured by an independent experiment, cf. Evans (R. S. I. **4**, 223 (1933)), then the other may be obtained.

8. The Heat of Dissociation of Bi_2 Determined by the Method of Molecular Beams. CHENG CHUAN KO, *University of California at Berkeley.* (*Introduced by Leonard B. Loeb.*)—With the velocity analyzer of Zartman with improved technique the combined velocity spectrum of Bi atoms and Bi_2 molecules was obtained at 827°, 851°, 875°, 899°, 922°, 947°C. From the spectral distribution curves the relative abundance of Bi atoms and Bi_2 molecules in the beams at the above temperatures could be determined to 1 percent. The vapor pressure curve of Bi was obtained experimentally by the method of effusion and the values so obtained were combined with the degree of dissociation of the vapor as computed from the beams to give the heat of dissociation. The heat of dissociation was computed from the data, assuming the pressure to be given by the temperature of the crucible T_c. In calculating the heat of dissociation, the equilibrium temperature was taken as that of the slit chamber T_s which was 24° above T_c. The results of these calculations plotted with $\log_{10}K_p$ as ordinates against $1/T_s$ give a straight line whose slope yields the value of the heat of dissociation as 73,916±3283 calories. The curves for the distribution of velocities observed and computed on the assumption of a given ratio of Bi atoms to Bi_2 molecules in the beam were compared to test the law of distribution of velocities. On the high velocity side agreement was obtained within the limits of experimental accuracy. On the low velocity side deviations were noted of such a sort that the observed curves below a velocity of $\alpha/2$ (i.e., ½ the most probable) gave *more* molecules than the theory demanded. Other

deviations were observed on some of the runs taken with a fourth slit in which a *deficiency* of molecules was observed between velocities of 0.75α and $\alpha/2$. This deviation was probably due to a warping of the image slit carriage due to heat. The nature of the variation at velocities less than $\alpha/2$ indicated the presence of molecules of greater mass than Bi_2 in the beam and at the lower temperatures a distinct peak corresponding to Bi_3 molecules was observed which were present to less than 2 percent.

9. Charging Devices for Portable Ionization Electroscopes. E. J. WORKMAN, *Reed College.*—The increasing use of portable ionization electroscopes for radiation measurement has created a demand for lighter and more compact sources of potential for charging than is obtainable by the use of commercial dry batteries. One method of meeting this need depends upon the use of a small variable air condenser and a dry battery of a few volts. A well insulated (hard rubber or better) variable radio condenser of approximately 900 cm capacity is charged to a potential of 22 volts by a small C-battery. A turn of the dial toward smaller capacity disconnects the battery and connects the condenser to the deflecting element of the electroscope when the potential has been raised the desired amount. All switching is controlled by a mechanism on the dial shaft and with a given arrangement of connections the electroscope can repeatedly and accurately be charged to the desired potential. In cases where pocket size equipment is desirable a 1.4 volt flash light battery may be used with a small, say 4 cm in diameter, parallel plate condenser. A thin sheet of mica serves for the dielectric at the position of maximum capacity and the separation of the plates and switching action is accomplished by pressing the charging "button" of the electroscope into contact with the charging device. Crude apparatus of this type has been found satisfactory for charging a small deflecting element to potentials around 300 volts, but is less reliable because of the "creeping" action on the dielectric.

10. The Study of a Powerful Source of Positive Alkali Ions. PAUL KECK and LEONARD B. LOEB, *University of California at Berkeley.*—A positive alkali ion source was developed in which an atomic beam of alkali atoms was projected against a platinum strip filament at 1000°C in a high vacuum. By accelerating the resulting positive ions in an electrical field positive ion currents of the order of 2×10^{-4} amperes/cm^2 could be obtained with the source of potassium at 330°C and a potential of 340 volts. Over 60 percent of the atoms in this beam had an energy distribution of less than 25 volts. This device can be further developed and could be used for the study of light emission by positive ion impact at low voltages, for an effective separation of the Li isotopes when coupled with a positive ray analyzer at the rate of 0.13 mg Li per day, and as a 3 electrode tube for the production of electrical oscillations.

11. Azimuthal Investigation of Cosmic Radiation. S. A. KORFF (*National Research Fellow*), *Mt. Wilson Observatory.*—A study is being made of the distribution of cosmic radiation east and west of the magnetic meridian, employing Gieger-Müller counters connected to record coincidental discharges. Preliminary results indicate that at the Mt. Wilson laboratories, Pasadena (elev. 885 ft.), counting rates at equal altitude angles east and west are equal within the experimental errors of about 4 percent. This result is in agreement with the observations of Millikan and Neher, and with the calculations of LeMaitre and Epstein. The experiments are being continued at higher elevations.

THURSDAY AFTERNOON, JUNE 15TH, AT 2 O'CLOCK

Room 313, Physical Science Building

Joint Meeting with the A.S.P.

1. Photographic Studies of the Planets in Light of Different Wave-Lengths. W. H. WRIGHT

2. Spectra of Mars, Venus, and Jupiter under High Dispersion. T. DUNHAM

3. Molecular Spectra in the Photographic Infrared. (To be read.) D. M. DENNISON AND A. ADEL

4. Radioactivity and the Age of Meteorites. R. D. EVANS